Chapter 6

Hyoid and Vertebrae

In early vertebrates, a chain of cartilage-replacement bones formed around the notochord to give it stiffness. Over time, these bones developed processes that wrapped around the dorsal side of the nerve cord. Today we know these bones as vertebrae, elements from which the entire subphylum Vertebrata derives its name. In most modern vertebrates, the vertebrae have replaced the notochord as the principal means of support for the central part of the body. The sacrum and coccyx are vertebrae, but they function as parts of the bony pelvis. The hyoid bone, an intermediary between the skull and postcranial skeleton, combines skeletal elements of the second and third pharyngeal arches associated with the gills of primitive fish.

6.1 Hyoid (Figure 6.1)

6.1.1 Anatomy

The hyoid bone is located in the neck and can be palpated immediately above the *thyroid cartilage* (the protuberance on the anterior surface of the neck). It is the only bone in the body that does not articulate with another bone. Instead, it is suspended from the tips of the styloid processes of the temporal bones by the *stylohyoid ligaments*. The hyoid gives attachment to a variety of muscles and ligaments that connect it to the cranium, mandible, tongue, larynx, pharynx, sternum, and shoulder girdle. Its shape is highly variable and it is often fractured in forensic cases involving strangulation (Pollanen and Ubelaker, 1997). The U-shaped hyoid consists of three major parts that are variably fused:

a. The **body** straddles the midline. It is a thin, posterosuperiorly concave, curved bone that articulates with, or is fused laterally to, the hyoid horns.
b. The **greater horns** are long, thin structures that form the posterior sides of the hyoid bone and project posterolaterally from the body on either side. The tip of each horn is a slightly expanded tubercle that serves as the attachment for the *lateral thyrohyoid ligament*.
c. The **lesser horns** are small, conical eminences on the superior surface of the bone in the area where the body and greater horns join. Their variably ossified apices give attachment to the *stylohyoid ligaments*.

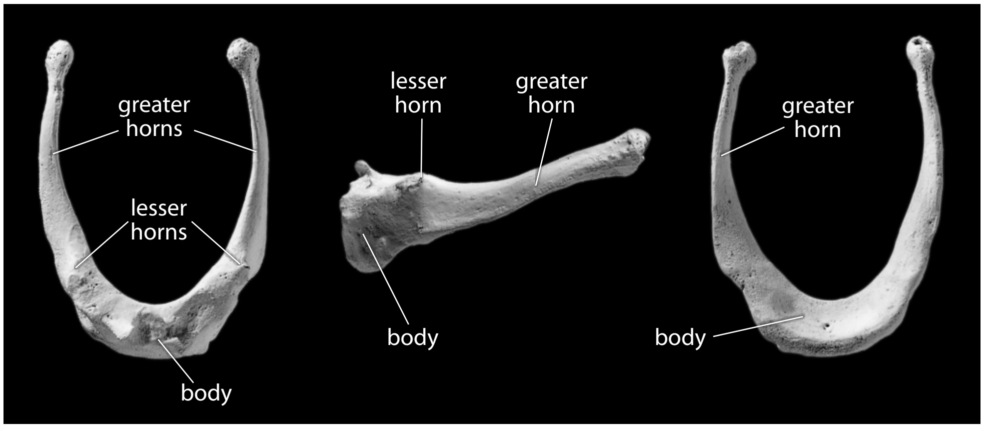


Figure 6.1 **Hyoid.** *Left:* superior view, posterior is up; *center:* lateral view, anterior is to the left, superior is up; *right:* inferior view, posterior is up. Natural size.

6.1.2 Growth

The hyoid ossifies from six centers: two for the body and one for each of the greater and lesser horns.

6.1.3 Possible Confusion

Hyoids are mistaken most frequently for immature vertebral sections.

- The body is far thinner and more plate-like than a vertebral centrum, or even any part of a vertebral arch.
- The horns are longer and thinner than the spinous processes of any vertebral element.

6.1.4 Siding

- The widest part of the greater horn is anterior, and the horn thins as it sweeps posteriorly, superiorly, and laterally to end in the tubercle.
- The superior surface bears the lesser horns.

6.1.5 Hyoid Measurements

Measurements of the hyoid are rarely taken or used, and can be defined as appropriate to the research question.

6.1.6 Hyoid Nonmetric Traits

- There are no commonly cited nonmetric traits on the hyoid, and variation in this element is rarely noted.

6.2 General Characteristics of Vertebrae

Because the fused vertebrae of the sacrum and coccyx form part of the bony pelvis, they are described in Chapter 14. This chapter describes the 24 movable vertebrae — the seven cervical, 12 thoracic, and five lumbar vertebrae. In this section we introduce parts common to most vertebrae; in the following sections we concentrate on each class of vertebra.

6.2.1 Anatomy (Figures 6.2–6.4)

The vertebral column is most often composed of 33 elements in the adult human. Of these, 24 are separate (movable vertebrae), and the others are variably fused within the bony pelvis. It should always be possible to identify isolated, even fragmentary individual vertebrae by type — cervical, thoracic, or lumbar. Cervical vertebrae are in the neck, thoracic vertebrae in the thorax, and lumbar vertebrae just superior to the bony pelvis. Within these units, individual vertebrae are designated by letter (L, lumbar; T, thoracic; and C, cervical) and identified by number from superior to inferior. For example, the most superior thoracic vertebra is designated T-1.

Successive vertebrae articulate directly with one another across synovial joints. All moveable vertebrae have two superior and two inferior articular facets. These four facets control movement between adjacent vertebrae; their shapes are the key to the function and identification of different vertebrae. Individual vertebrae are united within the vertebral column by ligaments and muscles that hold them together as a flexible unit. The three primary functions of each vertebra are to bear body weight, to anchor muscles and ligaments, and to protect the *spinal cord*. When the entire column or large segments of the column are available for a single individual, it is easy to identify each vertebra by type and number. From the cervical vertebrae through the lumbar vertebrae, each successive vertebral body (or centrum) is larger caudally because of successively greater weight-bearing responsibilities. Some individual vertebrae, like the atlas (C-1), are diagnosed easily, even if isolated, because of their unique morphology. Others, particularly mid-cervicals and mid-thoracics, are far more difficult to identify by number when found disassociated from the other vertebrae.

In life, adjacent vertebrae are separated by *intervertebral disks* that are made up of concentric rings of specialized fibrocartilage. Each disk is composed of a circumferential band of fibrous tissue and fibrocartilage known as the *annulus fibrosus*. At the center of the disk is a soft substance known as the *nucleus pulposus*. These tissues are surrounded by a *fibrous capsule,* which binds together adjacent vertebral bodies and encapsulates the disks. These soft tissue components are critical for movement in the vertebral column. The intervertebral disks make up more than one-fifth of the column's total height in life and contribute to its distinctive longitudinal curvature. Disks are thickest in the lumbar and cervical regions where the vertebral column is most freely movable.

Individuals can vary in the number of vertebrae they have in each category. This variation may occur in over 10% of all individuals in a skeletal population. Variation from the usual condition most often involves the shifting of a vertebral element from its typical category to an adjacent category. The most frequent deviation from the usual pattern of 7 cervical, 12 thoracic, and 5 lumbar vertebrae is the case of an extra thoracic or lumbar vertebra with an associated shift, as with 13 thoracic and 4 lumbar vertebrae.

We first describe the basic components of any vertebra before describing particular vertebral categories:

a. The **vertebral foramen** is the hole in each vertebra through which the *spinal cord* passes. Each vertebra thus forms a segment of the vertebral canal passing down the vertebral column.
b. The **vertebral body** (or **centrum**) is a spool-shaped structure that constitutes the main weight-bearing portion of a vertebra (except in the cases of the atlas and axis). The body is very thin-walled, composed mostly of lightweight, fragile, spongy bone, and it is therefore

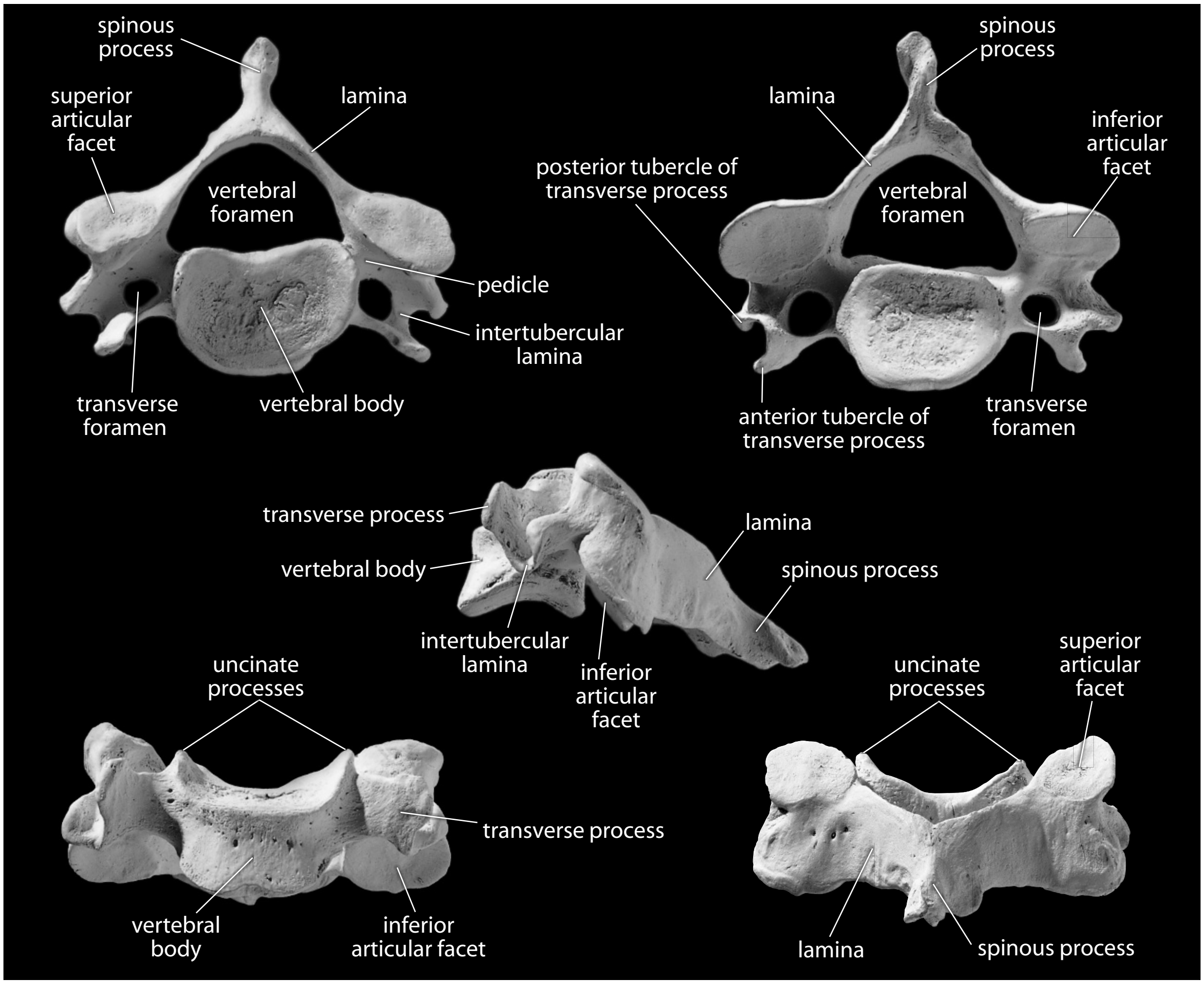


Figure 6.2 **Fifth cervical vertebra.** A "typical" cervical vertebra. *Top left:* superior view, posterior is up; *top right:* inferior view, posterior is up; *center:* left lateral view, posterior is to right; *bottom left:* anterior view, superior is up; *bottom right:* posterior view, superior is up. Natural size.

very susceptible to postmortem damage. It is also a center for blood production. The large foramen at the midline on its posterior surface is for the exit of the *basivertebral vein*.

c. The **vertebral** (or **neural**) **arch** encloses the *spinal cord* posterior to the vertebral body.

d. The **pedicle** is the short segment of the arch close to the vertebral body, attached more superiorly to the body than inferiorly.

e. Posterior to each pedicle is the **lamina**, the plate-like part of the arch that attaches the pedicle to the spinous process.

f. The **spinous process** projects posteriorly on the midline and serves to anchor the *interspinous* and *supraspinous ligaments* and several muscles. These ligaments limit flexion of the vertebral column. Because the spinous processes act as levers for muscular action, the length, size, and slope of individual spines depend on the functional role which various back muscles play.

g. One **transverse process** is found on each side of each vertebra. Like spinous processes, the transverse processes act as levers for the muscles attached to them. Movements of the axial skeleton are made possible by the muscles acting on these levers. Movement is

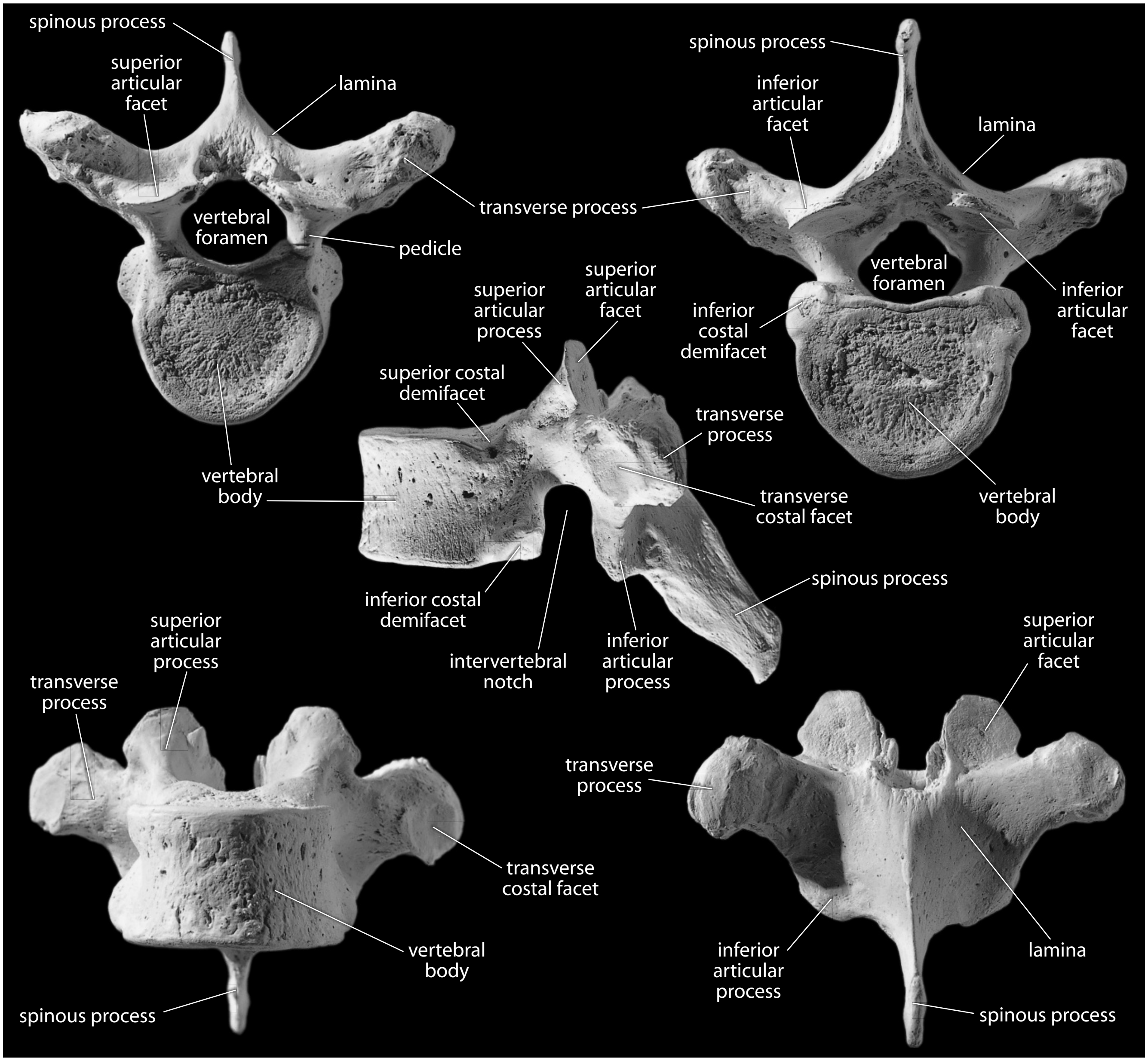


Figure 6.3 **Seventh thoracic vertebra.** A "typical" thoracic vertebra. *Top left:* superior view, posterior is up; *top right:* inferior view, posterior is up; *center:* lateral view, superior is up; *bottom left:* anterior view, superior is up; *bottom right:* posterior view, superior is up. Lateral view (center) is lit from the lower left to accentuate costal articulations. Natural size.

restricted by the ligaments that hold the individual vertebrae together. The transverse processes of thoracic vertebrae articulate with the ribs.

h. **Superior articular facets** face posterosuperiorly in most cervical vertebrae, posteriorly in the thoracic vertebrae, and posteromedially in the lumbar vertebrae.

i. **Inferior articular facets** face in the opposite directions of the superior facets for each vertebral class.

j. The superior and inferior articular facets of thoracic and lumbar vertebrae are located on **superior** and **inferior articular processes**, respectively.

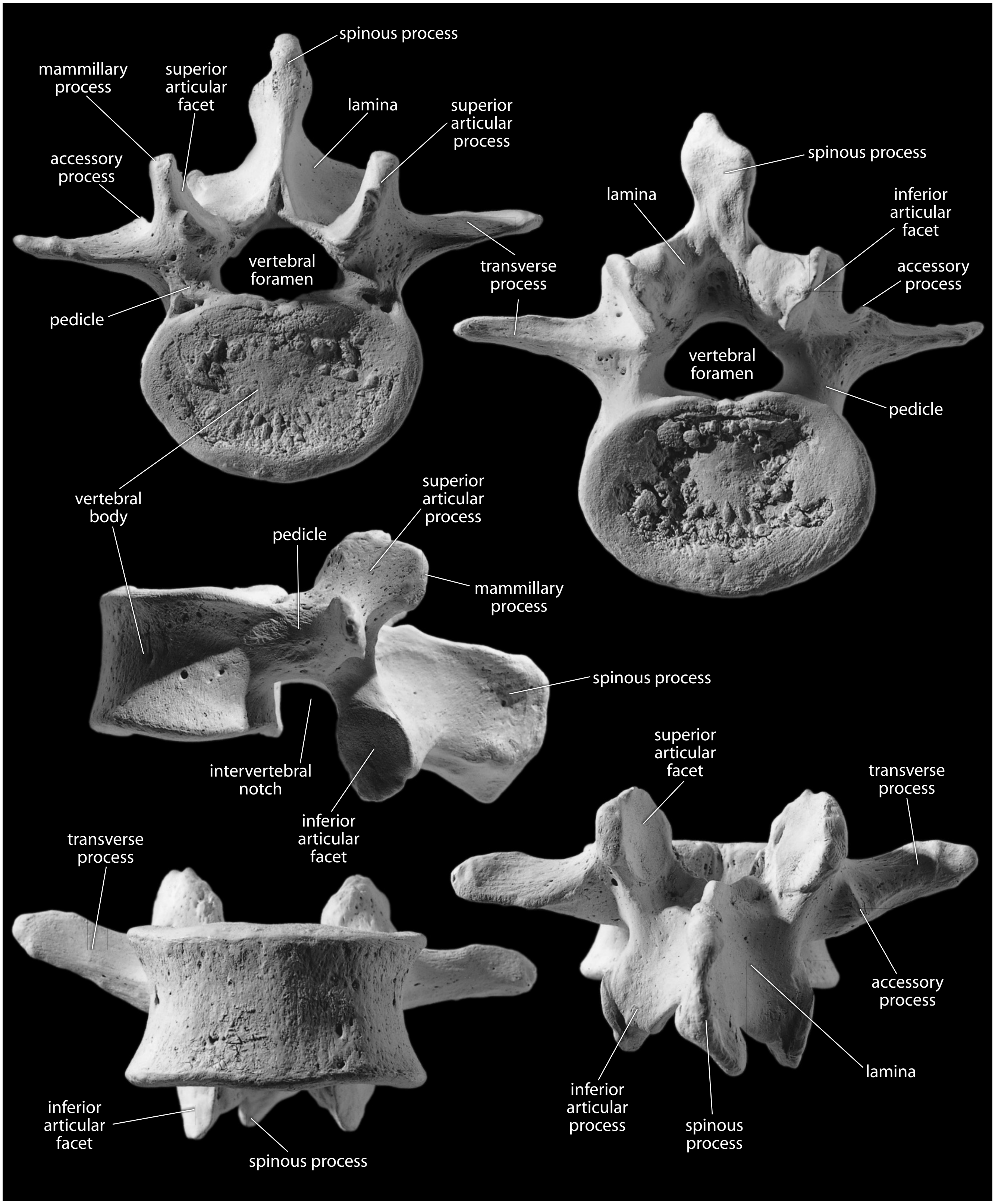


Figure 6.4 **Third lumbar vertebra.** A "typical" lumbar vertebra. *Top left:* superior view, posterior is up; *top right:* inferior view, posterior is up; *center:* lateral view, superior is up; *bottom left:* anterior view, superior is up; *bottom right:* posterior view, superior is up. Lateral view (center) is lit from the upper right to accentuate the spine and inferior articular facet. Natural size.

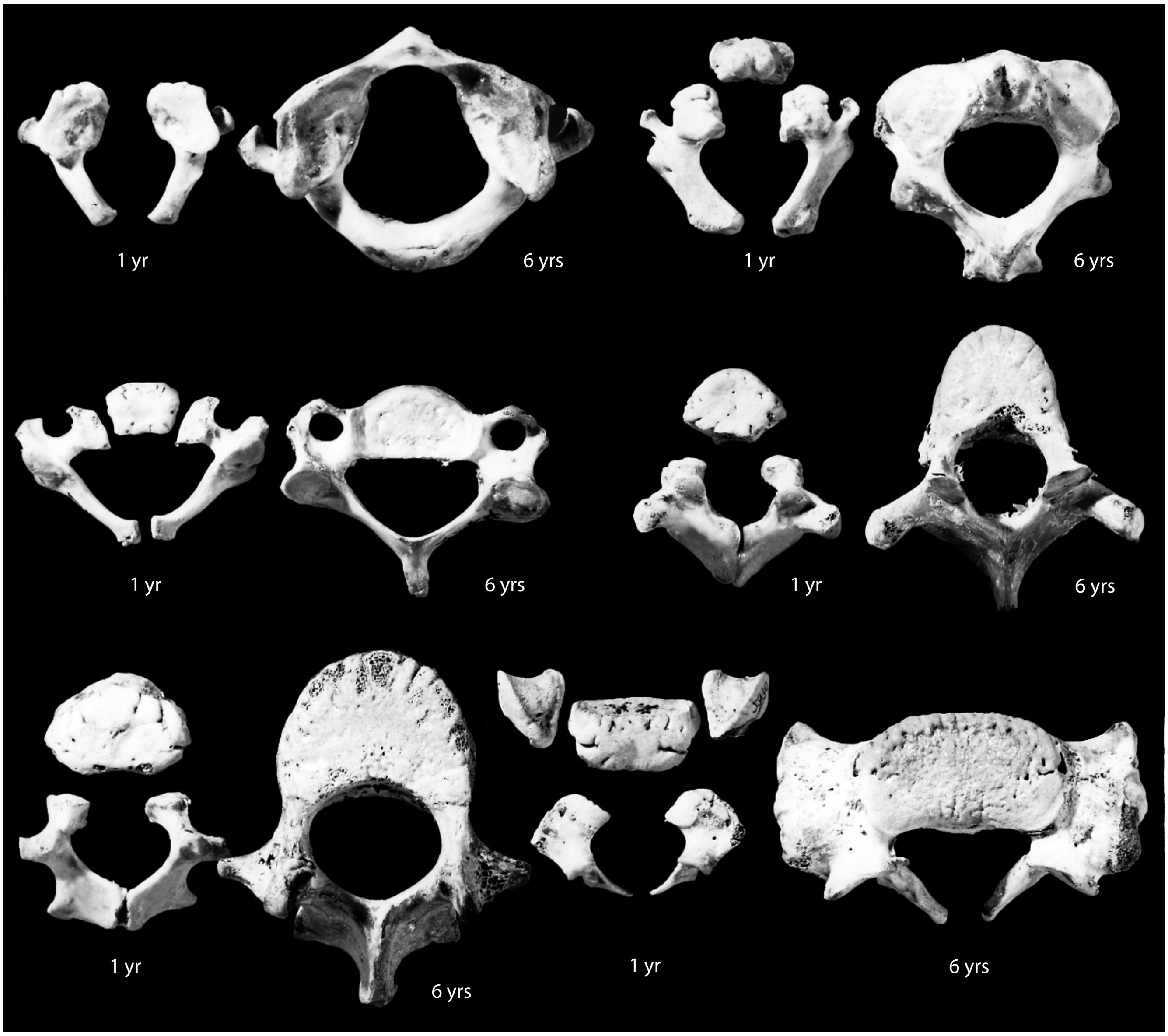


Figure 6.5 **Vertebral growth.** The pairs of immature vertebrae in superior view contrast a one-year-old with a six-year-old in each case. Top row: atlas (*left*), axis (*right*). Middle row: fifth cervical vertebra (*left*), fifth thoracic vertebra (*right*). Bottom row: second lumbar vertebra (*left*), first sacral vertebra (*right*). Anterior is up. Natural size.

6.2.2 Growth (Figure 6.5)

Most vertebrae ossify from three primary and five secondary centers. In immature vertebrae, the three primary centers are the centrum and the two halves of the vertebral arch (the body is composed of this centrum plus a small segment of each vertebral arch half). Secondary centers are found at the tips of each transverse process and of the spine. Flattened, ring-like apophyses surround the periphery of the superior and inferior surfaces of each body. The superior and inferior surfaces of immature vertebral bodies have a "billowed" appearance, with a thin bony ring instead of a round plate of bone (plates are found in many other mammals). This fuses to the body upon skeletal maturation.

6.3 Cervical Vertebrae (*n* = 7) (Figures 6.2 and 6.6)

Cervical vertebrae that share the characteristic cervical pattern are C-3 through C-6. We first describe this pattern and then assess the three remaining cervical vertebrae.

6.3.1 Anatomy and Identification

a. The **bodies** of cervical vertebrae are smaller and thinner than those of thoracic or lumbar vertebrae.
b. The **uncinate processes** on the lateral margins of the cervical bodies create bodies which have interlocking, saddle-shaped superior and inferior surfaces.
c. The roughly triangular **vertebral foramina** of cervical vertebrae are large and wide relative to the size of the vertebral body.
d. Cervical **transverse processes** are very small and gracile, and each is pierced by a **transverse foramen**. These foramina house the *vertebral arteries*, which pass upward to the posterior part of the brain.
e. The lateral portion of the cervical transverse process is complex, consisting of:
    1. a **posterior tubercle of the transverse process**, the small bump which is the cervical homolog of the tubercle of a rib.
    2. an **anterior tubercle of the transverse process**, another small bump which is the cervical homolog of a rib head.
    3. the **intertubercular lamina**, a downward-directed arch between the two tubercles which is the cervical homolog of a rib neck.
f. The **spinous processes** of cervical vertebrae project fairly horizontally behind the vertebral body (mostly posteriorly, partly inferiorly). They are usually bifurcated (bifid) from C-1 to C-5, and often asymmetrical at their posterior tips, shorter than thoracic spinous processes, and not as massive as lumbar spinous processes.
g. The **superior** and **inferior articular facets** of cervical vertebrae are cup-shaped or planar. The superior and inferior facets are parallel; both pass from anterosuperior to posteroinferior. The inferior facet is situated more posterior to the vertebral body than the superior facet.

6.3.2 Special Cervical Vertebrae (Figures 6.6–6.7)

- The **atlas** (C-1) lies between the cranium and the axis. Superior articular facets of the atlas are concave and elongate and receive the condyles of the occipital bone. The atlas vertebra has no vertebral body, lacks a spinous process, and has no articular disks superior or inferior to it. On the posterior surface of the anterior bony rim of this vertebra (the anterior edge of the vertebral foramen) there is an oval articulation for the dens of the axis.
- The **axis** (C-2) also lacks a typical vertebral body but has a projecting process (the **dens**, or **odontoid process**) that forms a pivot for the atlas. Thus, when the head is nodded up and down, movement is mostly at the joint between the occipital condyle and C-1. When the head turns from side to side, the atlas rotates about the dens of the axis.
- The **seventh cervical vertebra** (C-7) is transitional between a typical cervical and a typical thoracic vertebra. Its vertebral body is the largest of the cervicals and has a flat inferior surface. Its spine most closely resembles a thoracic spine and is usually the uppermost vertebral spine palpable in the midline of the back in a living individual.

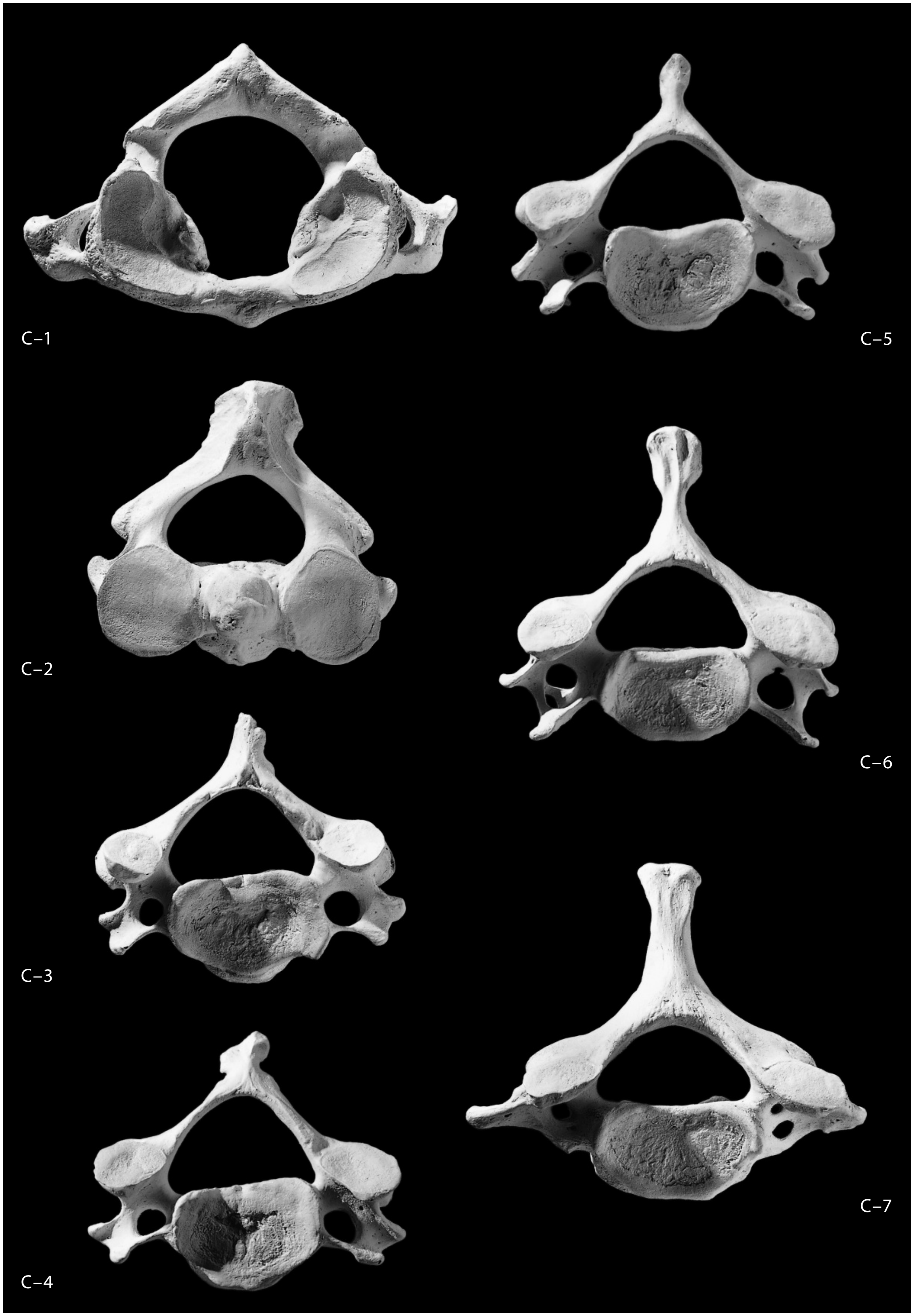


Figure 6.6 **Cervical vertebrae, superior.** Posterior is up. Natural size.

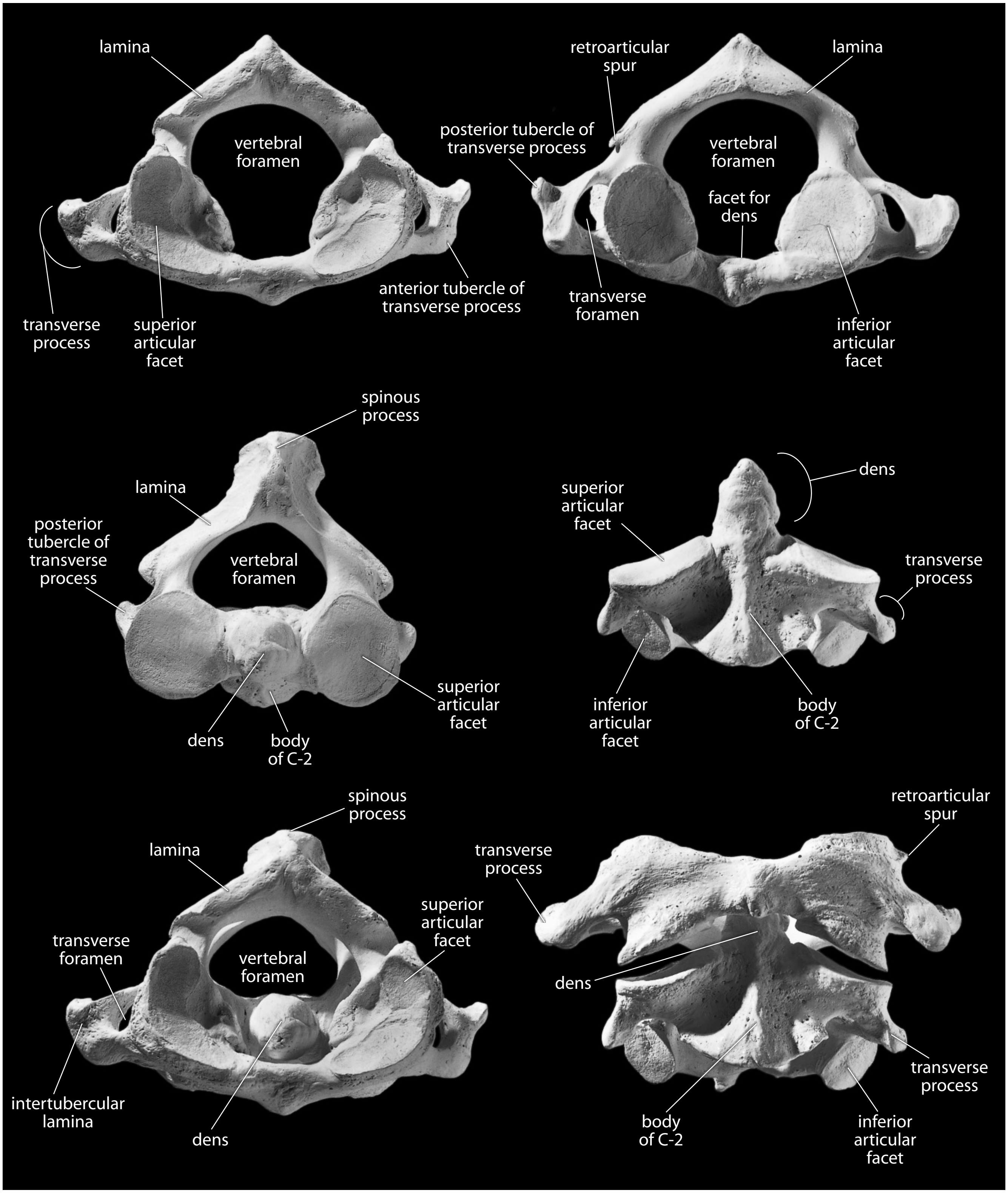


Figure 6.7 **Atlas and axis vertebrae.** *Top left:* atlas, superior view, posterior is up; *top right:* atlas, inferior view, posterior is up; *middle left:* axis, superior view, posterior is up; *middle right:* axis, anterior view, superior is up; *bottom left:* articulated atlas and axis, superior view, posterior is up; *bottom right:* articulated atlas and axis, anterior view, superior is up. Natural size.

6.3.3 Siding

- The long axis of the spinous process is directed posteroinferiorly.
- The superior articular facet faces posterosuperiorly, and the inferior one faces the opposite direction.
- The uncinate processes are superior and lateral.

6.4 Thoracic Vertebrae (*n* = 12) (Figures 6.3 and 6.8)

Thoracic vertebrae that share the characteristic thoracic pattern are T-2 through T-6. We first describe this pattern, then assess the four remaining thoracic vertebrae. Each thoracic vertebra articulates with a pair of ribs.

6.4.1 Anatomy and Identification

a. The **bodies** of thoracic vertebrae are intermediate in size between cervical and lumbar vertebrae. Upper thoracic bodies are roughly triangular in superior outline, whereas lower thoracic vertebral bodies are more circular.

b. Thoracic vertebrae bear **costal facets** (or **foveae**), articular surfaces for the ribs, on either the vertebral body, the transverse process, or both. **Transverse costal facets** are found on the anterior aspect of the lateral ends of transverse processes for T-1 through T-10. **Superior costal demifacets** are found at the superior margin of the posterior vertebral body on thoracic vertebrae T-2 through T-9. **Inferior costal demifacets** are found at the inferior margin of the posterior vertebral body on thoracic vertebrae T-1 through T-8. Complete **costal facets** are found on the posterior vertebral bodies of thoracic vertebrae T-1 and T-10 through T-12.

c. The **vertebral foramina** of thoracic vertebrae are round or diamond-shaped, and are subequal to (T-1), or substantially smaller than (T-2 to T-10), the size of the vertebral body.

d. The **transverse processes** of thoracic vertebrae are longer, larger, and more robust than those of cervical vertebrae, and do not possess transverse foramina. The angle of the transverse processes is nearly 180° at T-1 and gradually narrows to roughly 90° at T-11.

e. The **aortic impression** is a variable flattening that may be found on the left side of the bodies of mid-thoracic vertebrae. The impression usually becomes gradually more ventral from superior to inferior. The impression marks where the largest artery in the body runs against the vertebral column.

f. The **spinous processes** of thoracic vertebrae are longer and more slender than those of cervical or lumbar vertebrae, and each terminates in a distinct tubercle. From a lateral perspective, the spinous processes of the uppermost and lowermost thoracic vertebrae are closer to horizontal than the spinous processes of the middle thoracic vertebrae, which are much more inferiorly inclined.

g. The **superior** and **inferior articular facets** of all thoracic vertebrae but T-12 are very flat (planar). Except for T-1 and T-12, the articular facets are set vertically, facing directly anteriorly (the inferior facet) or posteriorly (the superior facet).

h. The superior and inferior surfaces of the **pedicle** have **superior** and **inferior intervertebral notches** for the *spinal nerves* that emerge from the *spinal cord* to innervate corresponding body segments. These nerves pass through the gaps formed by adjacent articulating notches, the **intervertebral foramina**.

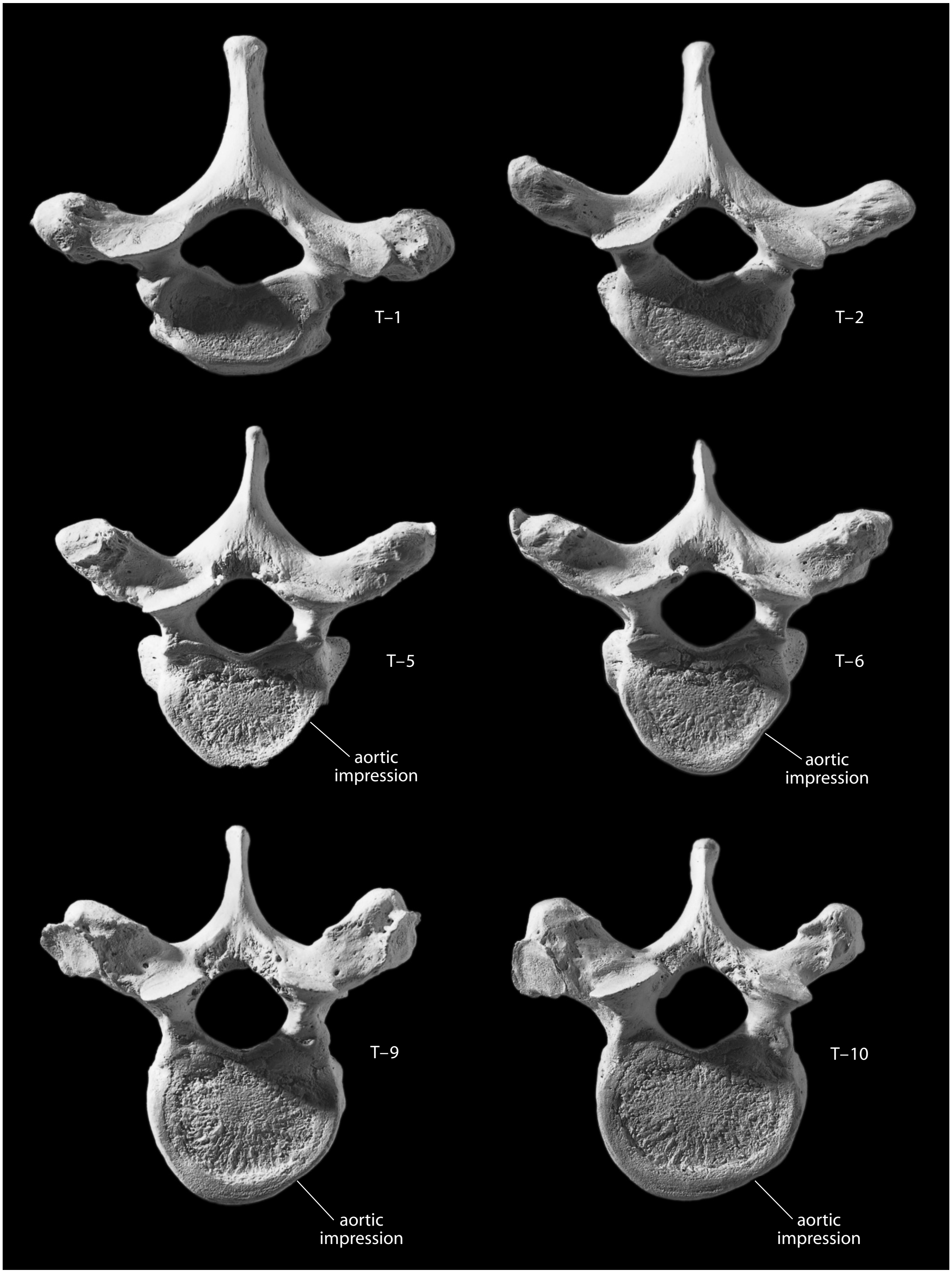
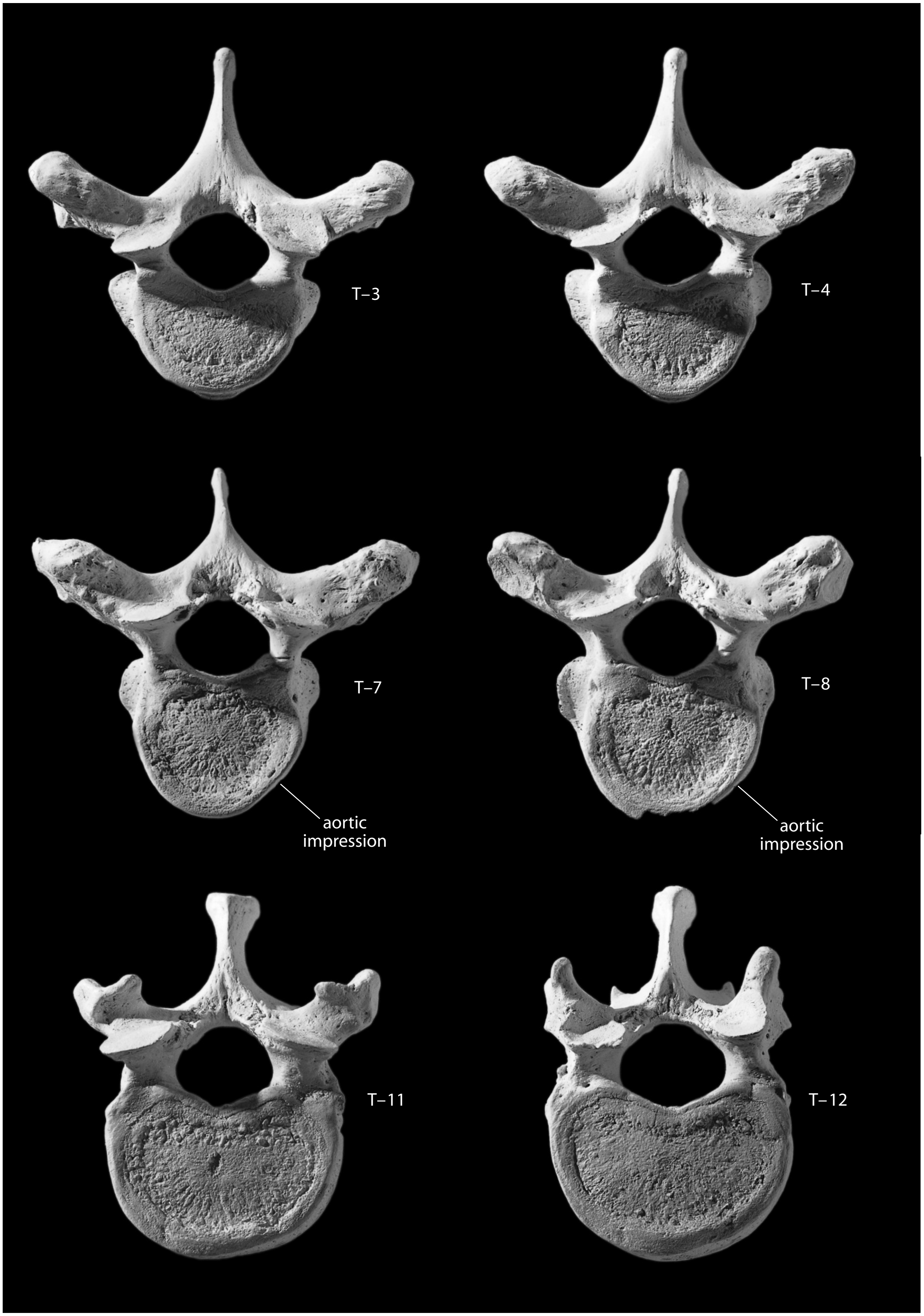


Figure 6.8 **Thoracic vertebrae, superior.** *(above* and *opposite)* Posterior is up. Natural size.


T–3
T–4
T–7
T–8
aortic
impression
aortic
impression
T–11
T–12

6.4.2 Special Thoracic Vertebrae (Figure 6.9)

- The **first thoracic vertebra** (T-1) has a whole costal facet superiorly and a half costal facet inferiorly. It retains more cervical-like characteristics of its spine and body than any other thoracic vertebra.
- The **tenth thoracic vertebra** (T-10) usually has a complete, superiorly placed costal facet on each side of the vertebral body and costal articulations on the transverse processes.
- The **eleventh thoracic vertebra** (T-11) has an intact, superiorly placed costal facet on each side of the vertebral body, but no costal articulation on the transverse processes.
- The **twelfth thoracic vertebra** (T-12) resembles T-11, but the inferior articular facets assume the lumbar pattern.

6.4.3 Siding

- The long axis of the spinous process is posterior and is angled sharply inferiorly, particularly in the mid-thoracic region.
- The superior articular facet faces posteriorly, and the inferior one faces anteriorly.
- The costal articulation on the transverse processes faces anterolaterally.
- In lateral aspect the inferior articular facets are separated from the rear half of the vertebral body by a considerable gap (the inferior intervertebral notch).
- The inferior dimensions of the body are greater than its superior dimensions.

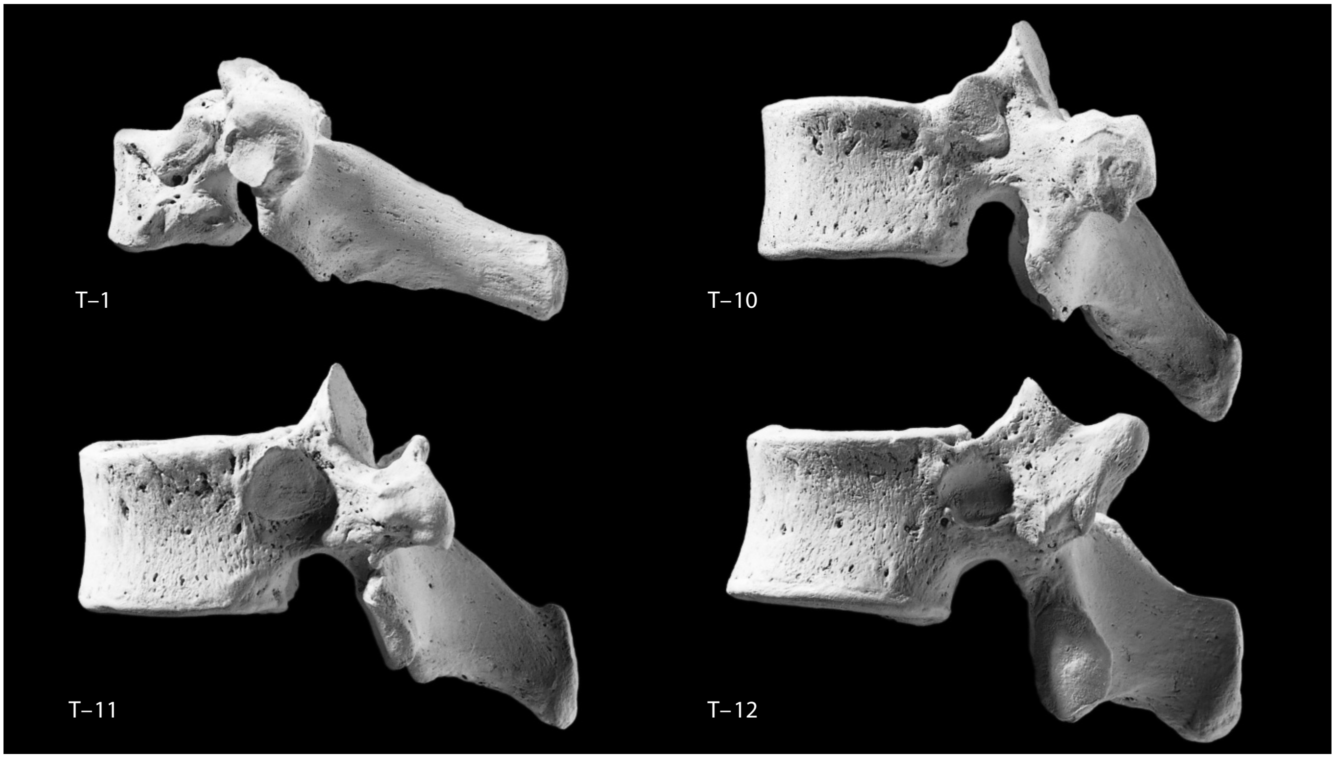


Figure 6.9 **Special thoracic vertebrae, lateral.** Superior is up. *Top left:* first thoracic vertebra; *top right:* tenth thoracic vertebra; *bottom left:* eleventh thoracic vertebra; *bottom right:* twelfth thoracic vertebra. Natural size.

6.5 Lumbar Vertebrae (*n* = 5) (Figures 6.4, 6.10, and 6.11)

It is comparatively easy to identify individual positions of isolated lumbar vertebrae. Like the thoracic and cervical vertebrae, the lumbars increase progressively in size from superior to inferior (L-1 to L-5). Lumbars are the largest of all the unfused vertebrae. Note that the individual illustrated in this manual has a sacralized L-5 with a pair of extra sacral articular surfaces.

6.5.1 Anatomy and Identification

a. The **bodies** of lumbar vertebrae are larger than those of cervical or thoracic vertebrae. Lumbar bodies lack costal pits and transverse foramina. The superior outlines of lumbar bodies are ovoid, although L-1 and L-2 may be somewhat kidney-shaped.
b. The **vertebral foramina** of lumbar vertebrae are triangular in outline, and are very small relative to the size of the vertebral bodies.
c. The **spinous processes** of lumbar vertebrae are hatchet-shaped, large, blunt, and more horizontally oriented than other vertebral spinous processes (they are orthogonal to the coronal plane).
d. The **transverse processes** of lumbar vertebrae are relatively smaller and thinner than thoracic transverse processes and they lack any articular surfaces. They are rudimentary or absent on L-1 and increase in size and projection inferiorly.
e. The **superior** and **inferior articular facets** are not parallel in lumbar vertebrae; instead, the superior articular facets are concave (cupped) and face posteromedially. The inferior articular facets are convex and face anterolaterally.
f. The **mammillary process** is a somewhat elongated tubercle that originates from the posterolateral margin of the superior articular process.
g. The **accessory process** is a variable, diminutive tubercle on the dorsal aspect of the base of the lumbar transverse process.

6.5.2 Identifying Lumbar Position

The L-1 is the smallest of the series. When viewing the posterior surface of a lumbar vertebra (Figure 6.11), imagine a quadrangle connecting the centers of four superior and inferior articular facets. In L-1 and L-2, this outline is a vertically elongate rectangle. In L-3 and L-4 the outline resembles a square. In L-5 the outline is a horizontally elongate rectangle.

6.5.3 Siding

- The long axis of each transverse process passes from the vertebral body and lamina superolaterally.
- The superior articular facets are concave and face posteromedially, whereas the inferior facets are convex and face anterolaterally.
- Note the large gap (the inferior intervertebral notch) between the inferior articular facets and the posterior surface of the vertebral body in lateral aspect. The arch originates from the superior half of the vertebral body.

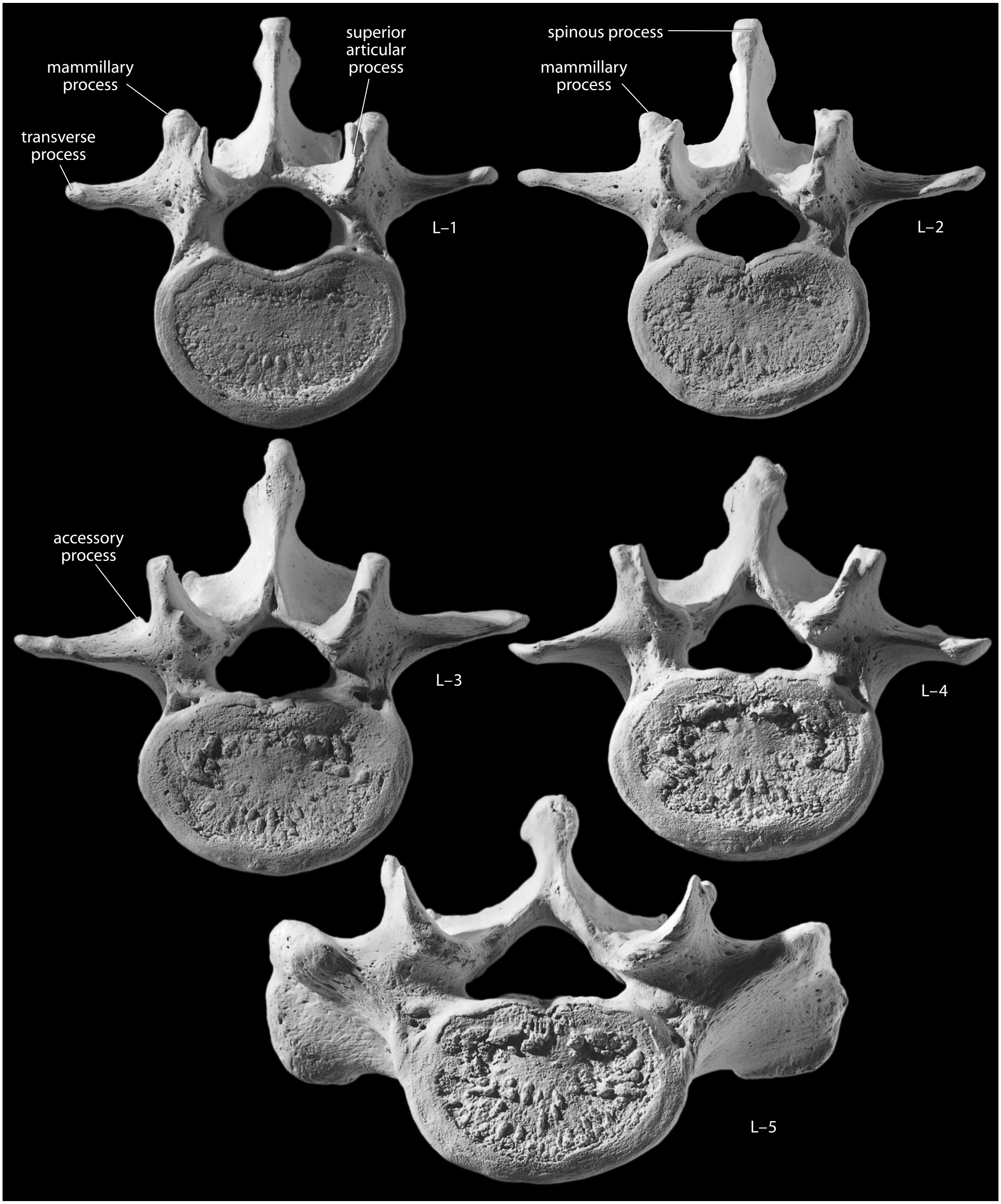


Figure 6.10 **Lumbar vertebrae, superior.** Posterior is up. Note that the L-5 of this individual is "sacralized" and articulates in five places with the sacrum. Natural size.

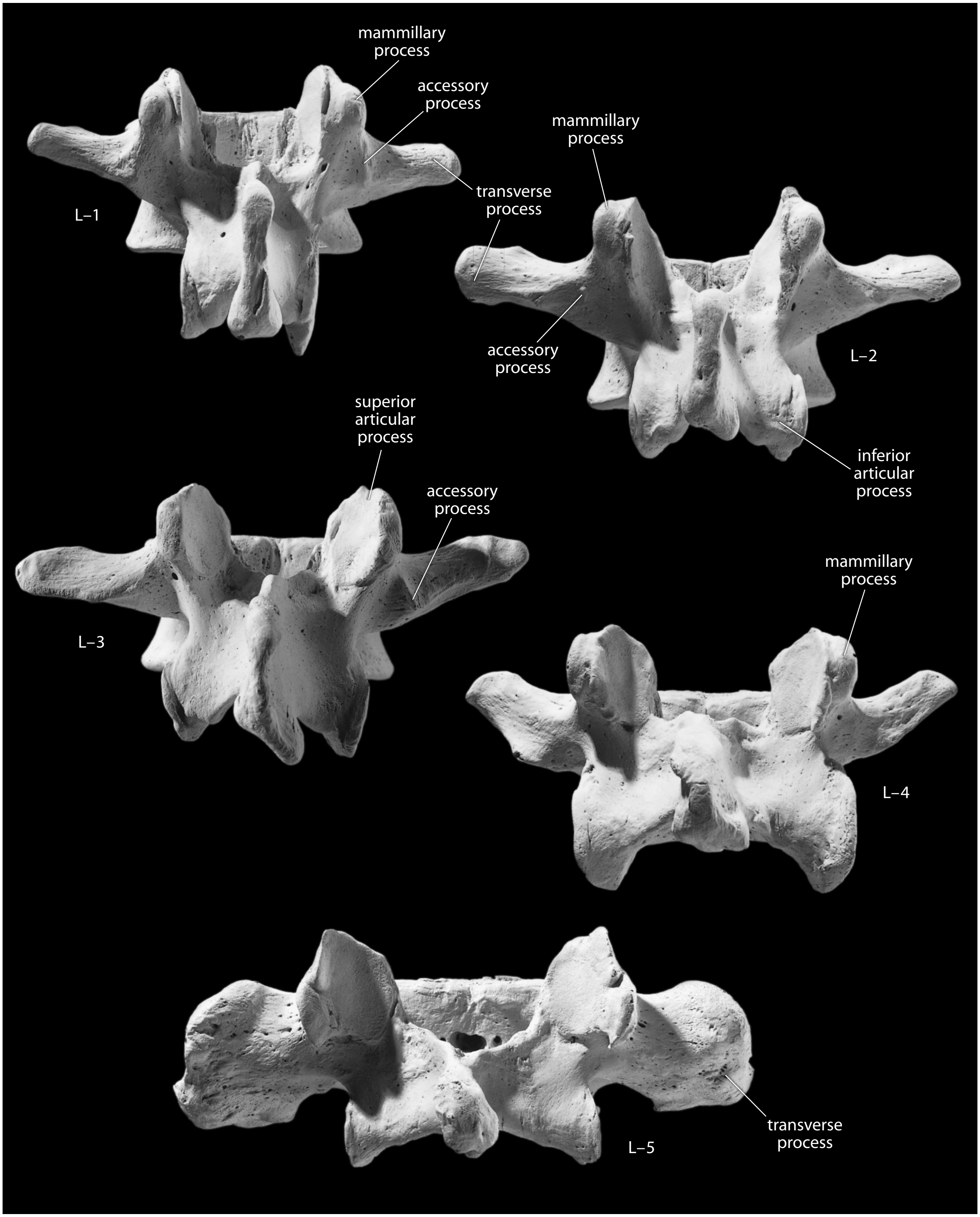


Figure 6.11 **Lumbar vertebrae, posterior.** Viewing the bones in this aspect allows their individual identification. Superior is up. Natural size.

6.6 Vertebral Measurements (Figure 6.12)

Measurements of the vertebrae are used for body mass estimation, stature reconstruction, posture reconstruction, locomotor analyses, and other analyses.

1. **Spinous process length** (O'Higgins et al., 1997: 107): Place the stationary end of the sliding caliper at the posteriormost point of the superior border of the vertebral canal at midline and, keeping the caliper parallel to the long axis of the spinous process, measure the distance to the distalmost tip of the spinous process.
2. **Spinous process angle** (Latimer and Ward, 1993: 287): Rest one arm of a goniometer on the midline of the cranial end of the body, and adjust the other arm so that it is parallel to the cranial edge of the spinous process.
3. **Ventral height of the body** (Martin, 1928: 998, #1): With a sliding caliper, measure the craniocaudal dimension of the ventral border of the body at midline.
4. **Superior dorsoventral body diameter** (Martin, 1928: 999, #4): With a sliding caliper, measure the maximum anteroposterior dimension of the superior surface of the vertebral body, including the annular rings. While the ventral point is taken at midline, the dorsal point is extended by the right and left projections of the vertebral disk surface.
5. **Superior transverse body diameter** (Martin, 1928: 999, #7): With a sliding caliper, measure the maximum transverse dimension of the superior surface of the vertebral body, including the annular rings.
6. **Vertebral canal length** (Martin, 1928: 1000, #10): With a sliding caliper, measure the maximum dorsoventral diameter of the cranial end of the vertebral canal.
7. **Vertebral canal breadth** (Martin, 1928: 1000, #11): With a sliding caliper, measure the maximum mediolateral diameter of the cranial end of the vertebral canal.
8. **Vertebral canal index** (Martin, 1928: 1000; Trinkaus and Svoboda, 2006: 292): (vertebral canal length $\div$ vertebral canal breadth) $\times$ 100.

6.7 Vertebral Nonmetric Traits

- **Shifts in vertebral numbers**: In some cases, the last vertebra of one region will mirror the morphology of the next caudalmost region (called a "caudal shift"), or the first vertebra of one region will mirror the morphology of the next cranialmost region (called a "cranial shift"). Such variation is much more common in the sacral and lumbar regions.
- **Retroarticular bridge or spur:** A bridge or spur is sometimes found on the atlas between the posterior transverse process and the vertebral arch immediately posterior to the superior articular (condylar) facet. The atlas illustrated in this book has a retroarticular spur on its right side (Figure 6.7).
- **Accessory transverse foramen in C-3 to C-6**: The transverse foramen is sometimes divided more cranially than C-7. The individual used to illustrate this book has a right accessory foramen at the level of C-6 (Figure 6.6).
- **Cervical rib**: In early tetrapods, each vertebra was associated with a pair of ribs, but in later mammals (including humans), only the thoracic vertebrae are associated with independent ribs. These cervical and lumbar ribs were not simply lost; they became reduced in size and were incorporated into the transverse processes of these vertebrae. Occasionally, however, a cervical rib will form and articulate with C-7. Such cervical ribs are highly variable; they may be very short, or they may extend all the way to the first costal cartilage.

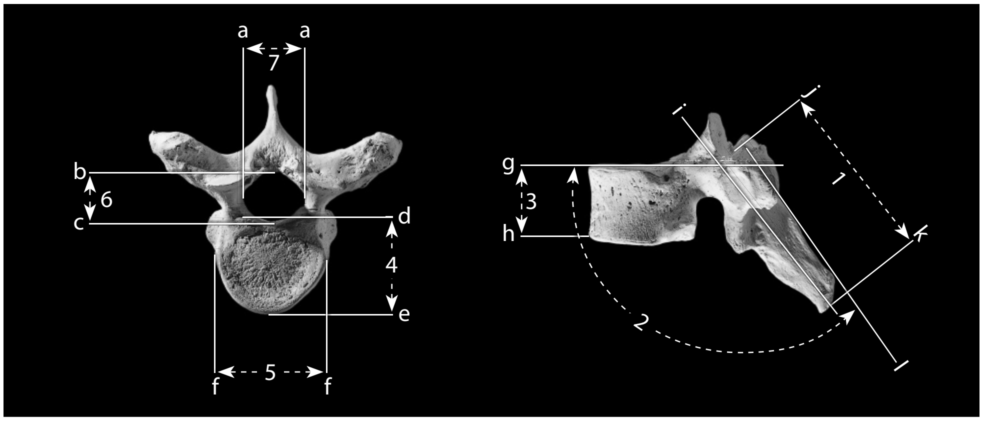


Figure 6.12 **Vertebral measurements.** One-half natural size.

Locations: a) lateralmost point of vertebral canal; b) dorsalmost point of vertebral canal; c) ventralmost point of vertebral canal; d) dorsalmost point(s) of superior vertebral body; e) ventralmost midline point of superior vertebral body; f) lateralmost point of superior vertebral body; g) line defined by the cranialmost midline points of the vertebral body; h) caudalmost ventral midline point of vertebral body; i) long axis of the spinous process; j) posteriormost point of the superior border of the vertebral canal; k) dorsalmost point on spinous process; l) line defined by the craniodorsalmost points of the spinous process.

Measurements: 1) spinous process length; 2) spinous process angle; 3) ventral height of the body; 4) superior dorsoventral body diameter; 5) superior transverse body diameter; 6) vertebral canal length; 7) vertebral canal breadth.

6.8 Functional Aspects of the Vertebrae

Compared to many other animals, humans have a specialized head, large limbs, and a relatively short vertebral column. Different portions of the column perform independent functions, and the shapes of the individual vertebrae are therefore different. The vertebral column can be divided into five regions: cervical, thoracic, lumbar, sacral, and coccygeal. The thoracic segment is concave anteriorly. The sacral and coccygeal segments are described in Chapter 11 on the pelvic girdle. Both the cervical and lumbar segments of the vertebral column are concave dorsally, permitting habitually erect posture. Most vertebrae share basic parts: arch, body, articular processes, transverse processes, and spinous processes. This correspondence of parts in sequential bones is called **serial homology**.

The different shapes of the different parts of each vertebra correspond to the functions they perform in different parts of the vertebral column. The most flexible part of the column is the neck, where cervical bodies are small, intervertebral disks are thick, and vertebral foramina are large, permitting much freedom of movement. Thoracic disks are much thinner, and the superior and inferior articular facets of these vertebrae are parallel. The lumbar region is second to the cervical in mobility, with thick disks and articular facets that are cup-shaped. Both thoracic and lumbar vertebrae allow anteroposterior bending of the column, but this movement is more restricted in the thoracic region. Medial and lateral bending of the column is also restricted in the thoracic region, but thoracic vertebrae allow for medial and lateral rotation (axial twisting of the column), which is limited in the lumbar region.